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The aerodynamic component of the damping of cantilevered test specimens oscillating near a rigid shield

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Abstract

© PNRPU. A numerical technique has been developed to process the experimental vibrogram of damped flexural vibrations of test specimens to determine the experimental lower frequency and the amplitude dependence of the logarithmic decrement of oscillations, which determines the damping properties of the test specimen. To determine the logarithmic decrement, the experimental envelope of damped flexural oscillations of the specimen's free end has been used. The experimental envelope was approximated by the sum of two exponents with four independent parameters, which was determined by the direct search for the minimum of the objective function that depends on these parameters. Numerical experiments were performed to show the reliability and sufficient accuracy of the developed procedure. It is shown that to determine the experimental aerodynamic component of the damping of a test specimen reliably, it is necessary that a test material has stable and low damping properties. Such requirements are fully met by duralumin. The experimental amplitude dependences of the logarithmic decrement for a series of duralumin test samples located at different distances from an absolutely rigid shield have been determined. On their basis, a theoretical-experimental method for determining the aerodynamic component of damping has been proposed by modifying the structural formula obtained earlier for determining the aerodynamic component of the damping of a thin rectangular planar elongated plate (test specimen) in the absence of a shield. Three additional parameters determined from the condition of a minimum objective function representing a quadratic discrepancy between the calculated and experimental values of the aerodynamic component of the damping of the test sample for several values of the length of its working part, and the distance to the rigid shield has been introduced into the formula. To find the minimum of the objective function, the Hook-Jeeves method has been used. This method does not require calculating its gradient at the current point in the space of the required parameters. Polynomial dependences of the found parameters on the dimensionless lower vibration frequency of the test specimen and the relative distance to the rigid shield are constructed. Numerical experiments have been carried out to confirm the validity of the developed method.

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Keywords

Aerodynamic damping, Damping bending vibrations, Direct search, Experiment, Logarithmic decrement of oscillations, Objective function, Test specimens

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